

USACE

Climate Variability Impacts Program

*Engaging the Corps of Engineers
in Climate Science*

Seshu Vaddey, PE – Seattle District

*Northwest Region Hydrology & Hydraulics CoP
Technical Forum, August 17, 2006*

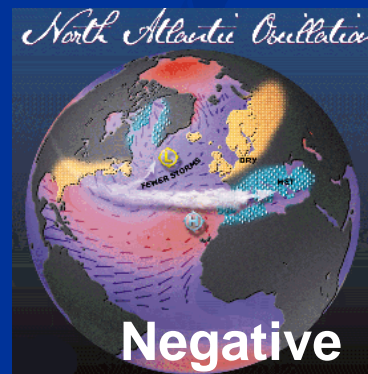
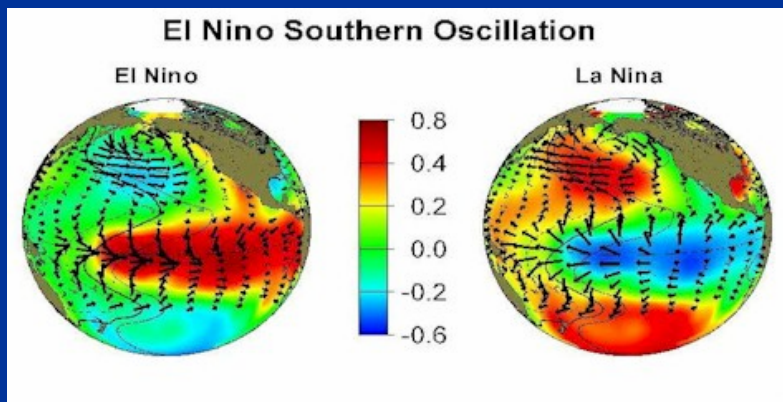
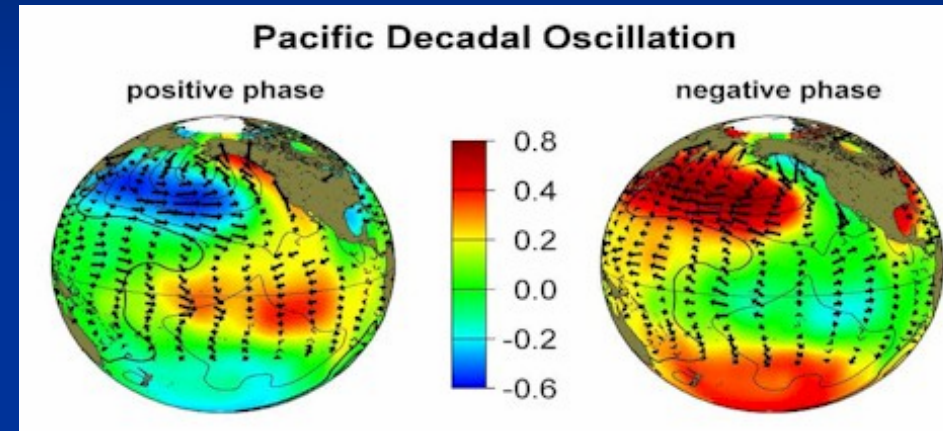
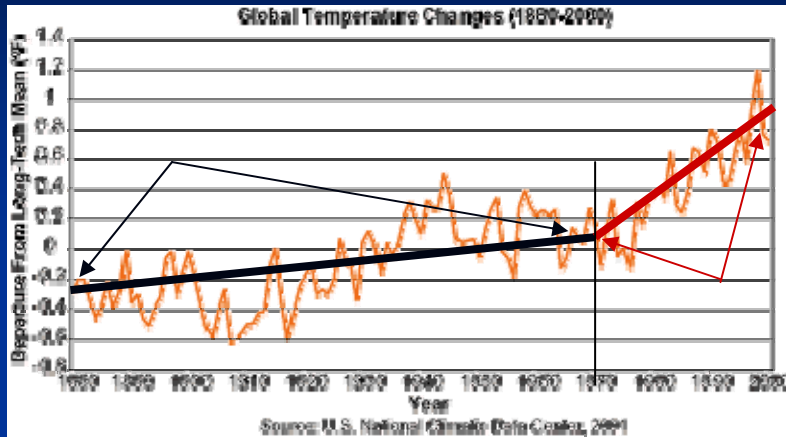
Outline

- Climate on our Doorstep
- Climate Variability PDT
- How to incorporate?

- Climate Research has brought climate science to the doorstep of Water Resources
- Background on the Climate Variability PDT
 - Rain vs. Snow – the difference in the West
 - Climate Science in the PNW
- How to Incorporate Climate Science into Water Resources
 - USBR experience in Calif. Central Valley Project
 - USACE Climate Variability PDT

Insight from Climate Research

- Climate on our Doorstep
- Climate Variability PDT
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What does it all mean?

- Climate on our Doorstep
- Climate Variability PDT
- How to incorporate?

■ For Water Resources Professionals:

- Either in the government or private sector?
- Affect on Day to Day operations?
- Short-term planning projects?
- Long-term planning?
- How should Risk & Uncertain be evaluated?
- How should projects & designs be changed?



■ For Policy Makers:

- How can uncertainty inherent in climate modeling be translated into policy
- Who is responsible for preparing for climate impacts? (i.e. costs)
- Who is accountable when things fail?



USACE Response: Climate Variability PDT

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- PDT of Western District USACE offices, Labs and Researchers has been assembled.
 - Albuquerque, Los Angeles, Sacramento, San Francisco, Portland, Walla Walla & Seattle Districts
 - Cold Regions Research & Engineering Lab (USACE-ERDC-CRREL), New Hampshire
 - University of Washington Climate Impacts Group
- Other Government agencies, Commissions, NGO's & Researchers are hoped to be brought into the process
 - NOAA, Reclamation, International Joint Commission, Nature Conservancy, Columbia River Treaty Committee, ...

- Climate on our Doorstep
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 - Rain vs Snow
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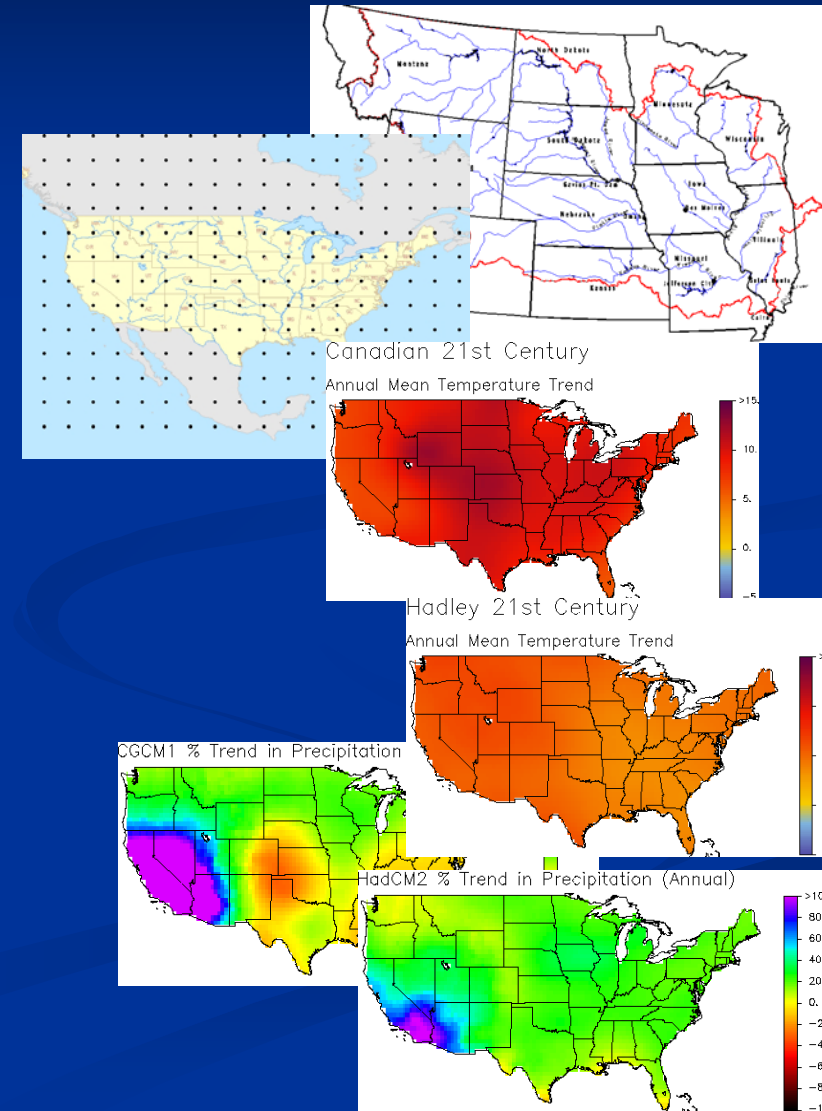
Why limit the team to the Western States?

USACE Study: Climate Change in the Upper Mississippi River System

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■ Conclusion of the Study

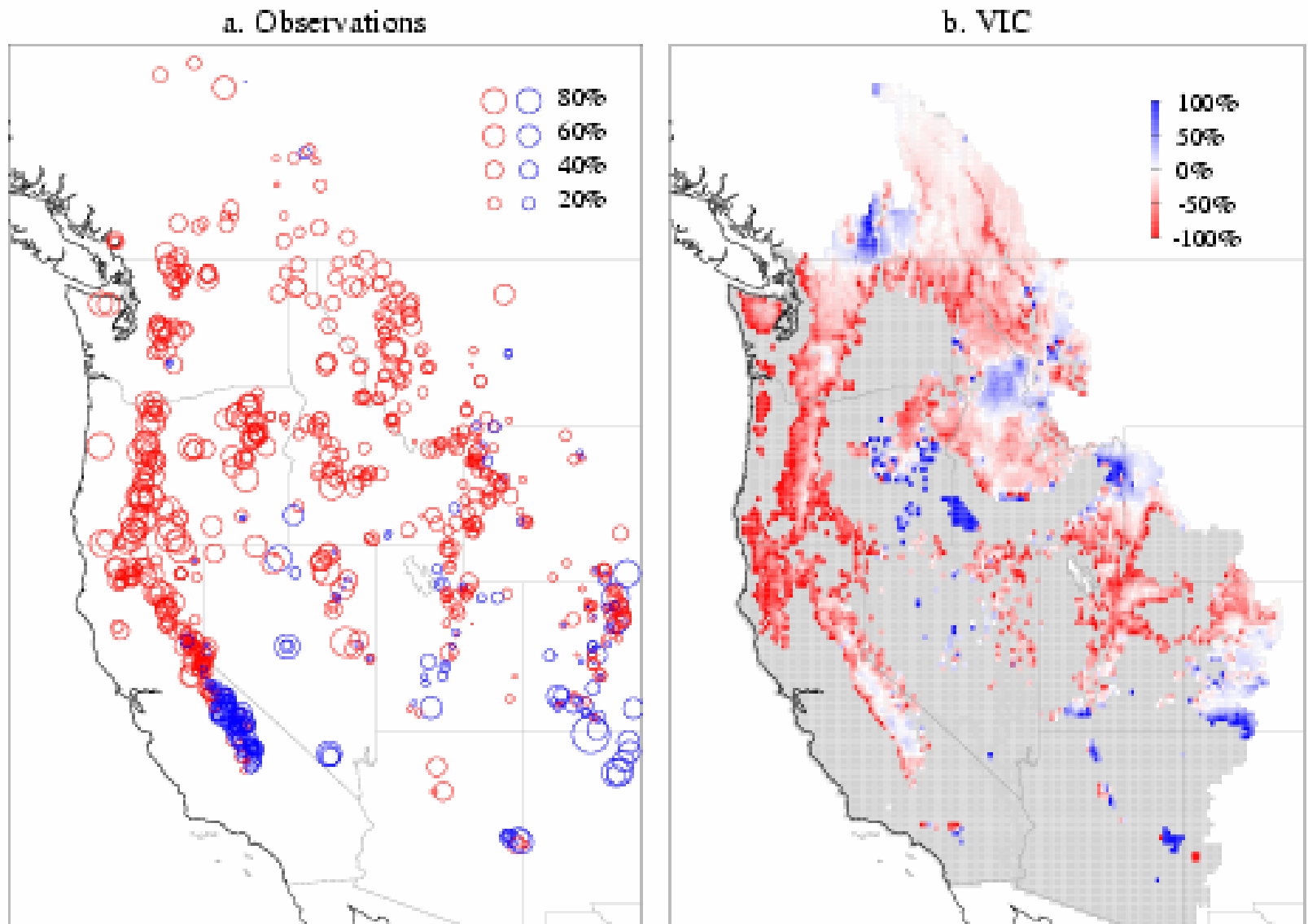
- Different climate models predict different directions of change for Middle Mississippi.
- Climate variability can affect flood frequency analysis and inland navigation with or without anthropogenic climate change.
- There is no one climate change scenario; depends on climate model and modeling assumptions.



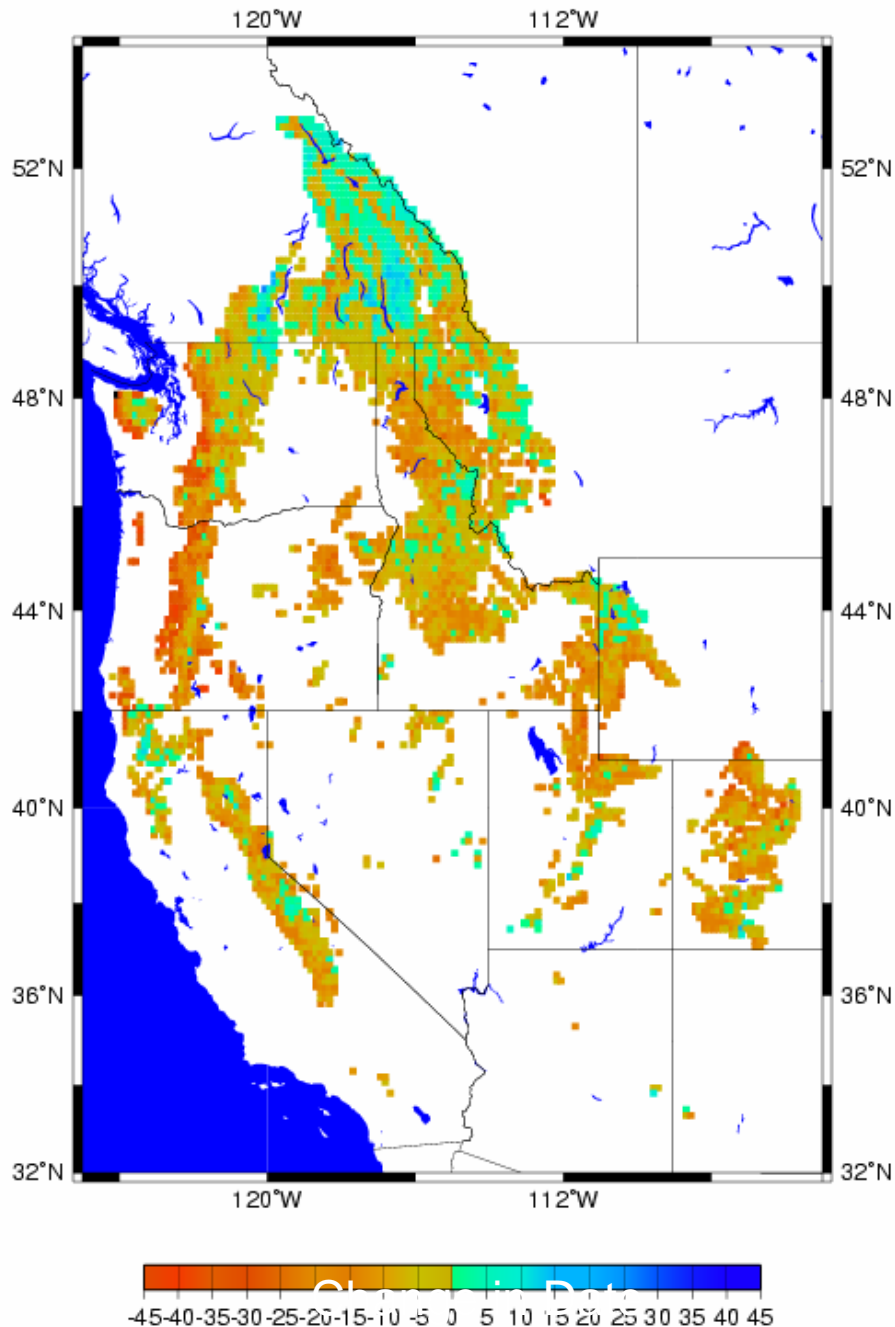
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Observed Hydrologic Changes

Trends in April 1 SWE 1950-1997



Mote P.W., Hamlet A.F., Clark M.P., Lettenmaier D.P., 2005, Declining mountain snowpack in western North America, BAMS (in press)



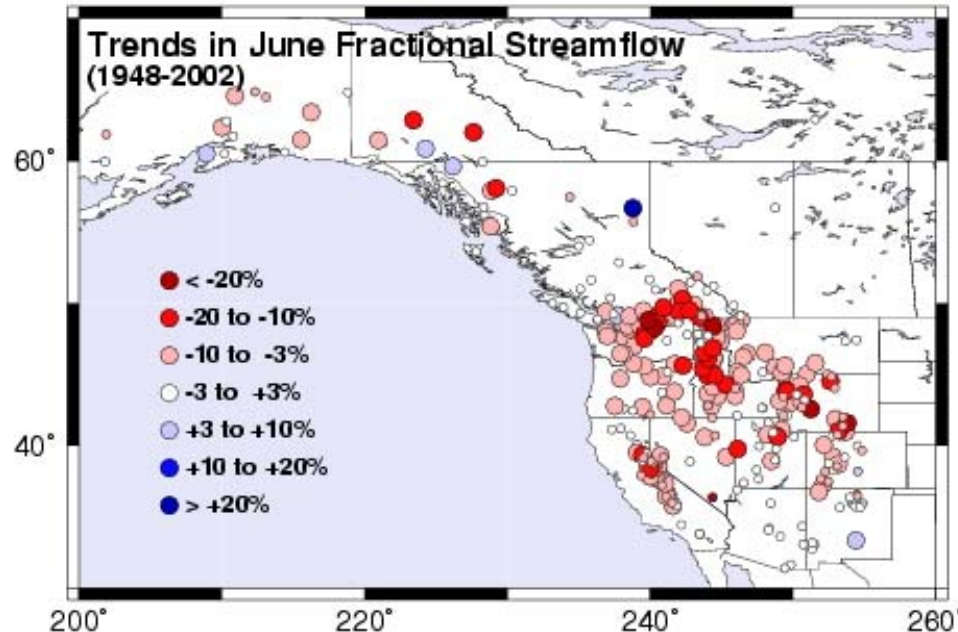
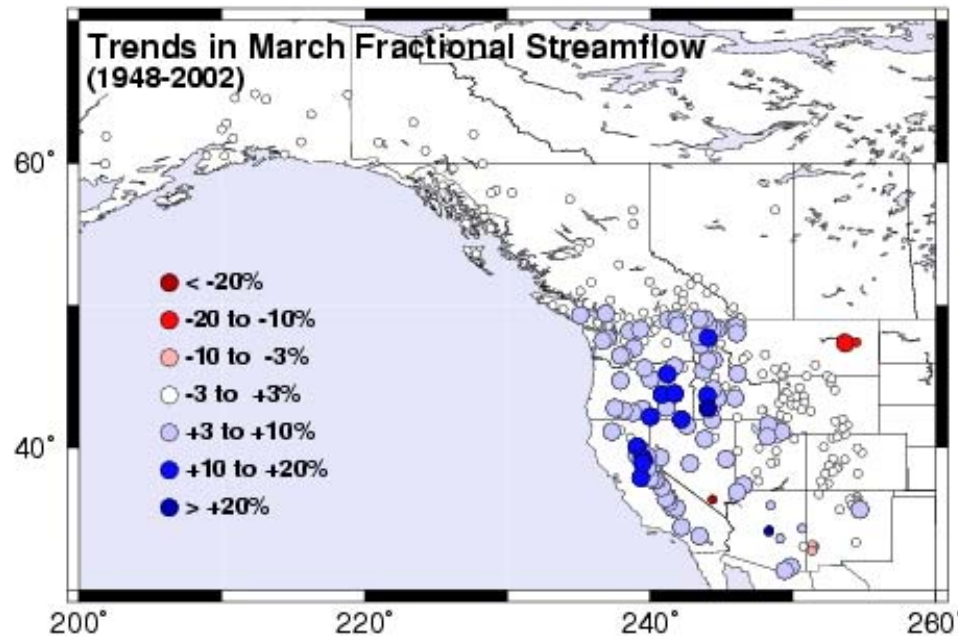
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Trends in timing of
peak snowpack are
towards earlier
calendar dates

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As the West warms,
winter flows rise
and summer flows
drop

Stewart IT, Cayan DR,
Dettinger MD, 2004,
Changes toward earlier
streamflow timing across
western North America, J.
Climate (in review)



from:
Stewart, I.T., D.R. Cayan, and M.D. Dettinger (2004)
Changes toward earlier streamflow timing across western North America
J. Climate, in review

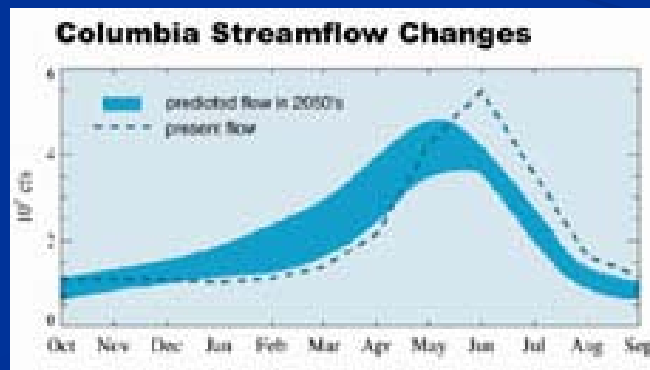
Conclusion for Western U.S.

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- Rain vs. snow is crucial to water issues in the West.
 - In California's Sierra Nevada, only 20-30 days deliver most of the year's water



- Streamflow timing shifts can be expected in the decades to come



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Global Climate Change Scenarios and Hydrologic Impacts for the PNW

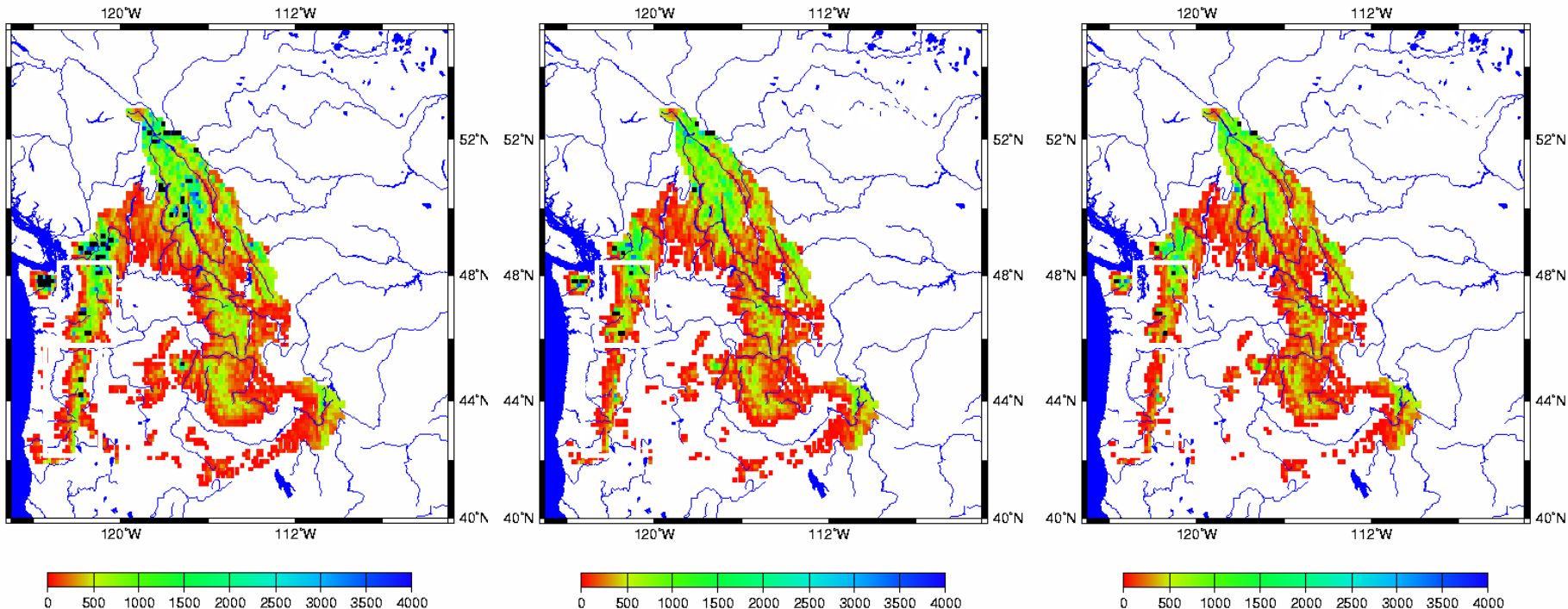
Changes in Simulated April 1 Snowpack for the Cascade Range in Washington and Oregon (% change relative to current climate)

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Current Climate

“2020s” (+1.7 C)

“2040s” (+ 2.25 C)



April 1 SWE (mm)

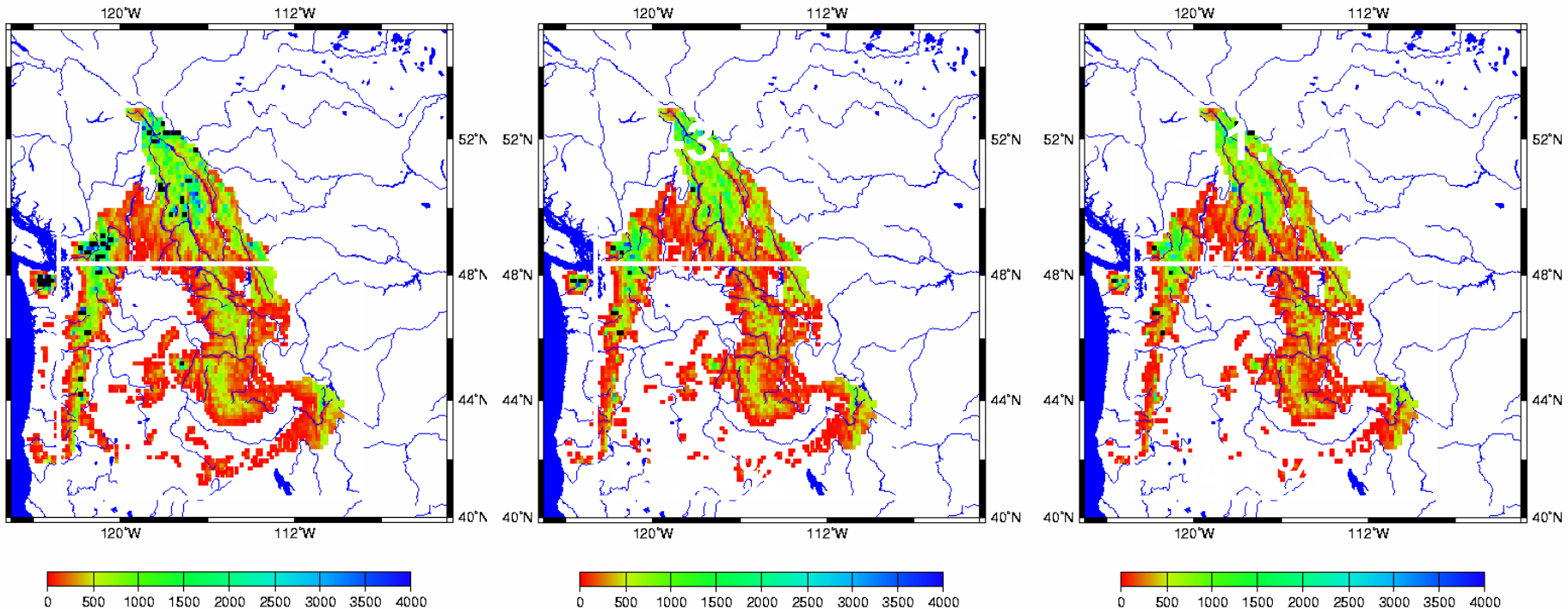
Changes in Simulated April 1 Snowpack for the Canadian and U.S. portions of the Columbia River basin

(% change relative to current climate)

Current Climate

“2020s” (+1.7 C)

“2040s” (+ 2.25 C)



April 1 SWE (mm)

The Question is How?

- How do we bring Climate Variability to bear on Water Resources Projects?

USACE Climate Variability Focus Group is
working on it

Reclamation: Is also working on it

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RECLAMATION *Managing Water in the West*

Reclamation/DWR Project to Assess Climate Change Risks for CVP/SWP Operations

1 March 2006

Pacific Grove, CA

Levi Brekke, Reclamation D-8520



U.S. Department of the Interior
Bureau of Reclamation

Project Highlights

- Climate on our Doorstep
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- Developing information on risk rather than potential impacts.
- Considering impacts and probabilities for a large ensemble of scenarios.
- Results on risk will frame analyses on adaptation and mitigation.

Risk Assessment

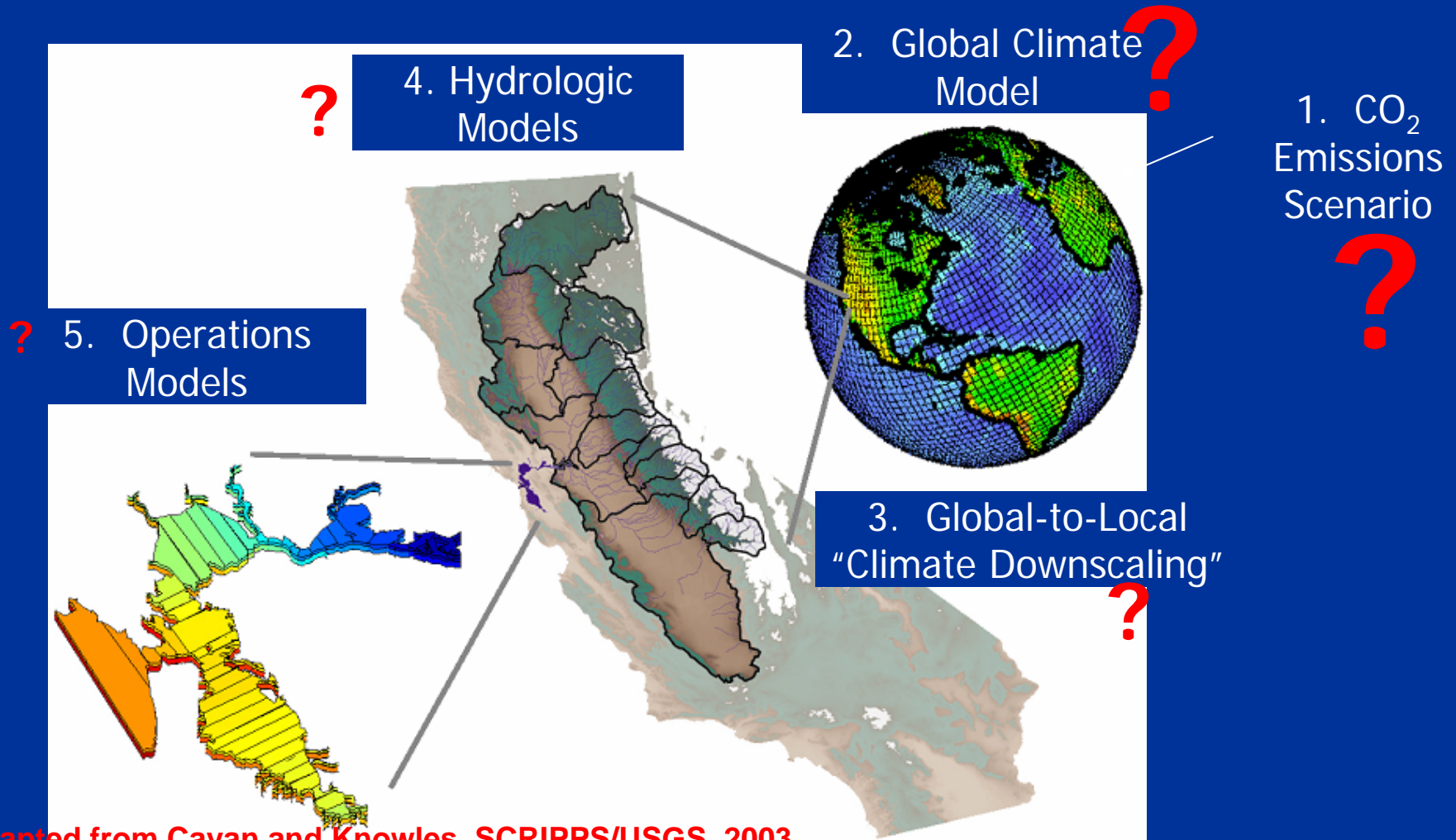
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1. Survey a spectrum of Scenarios
2. Analyze Scenario-specific Impacts
3. Estimate Scenario-specific Probabilities
4. Integrate Scenario Impacts & Probabilities to assess RISK



Probability depends on a number of uncertainties...

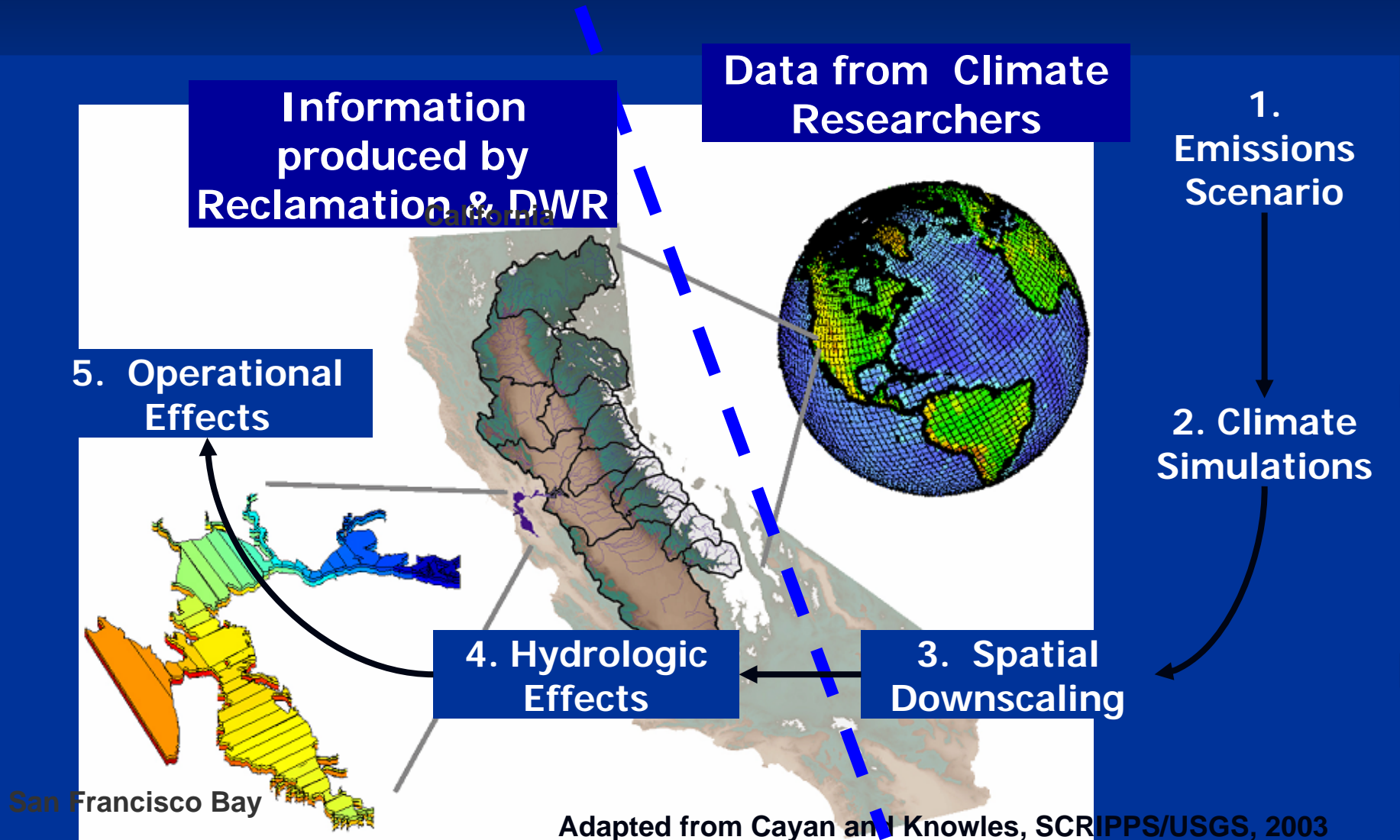
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Adapted from Cayan and Knowles, SCRIPPS/USGS, 2003

Spatial Information

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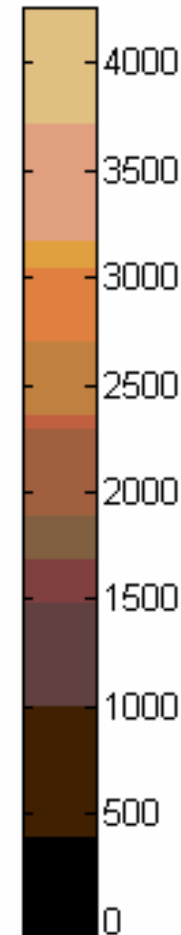
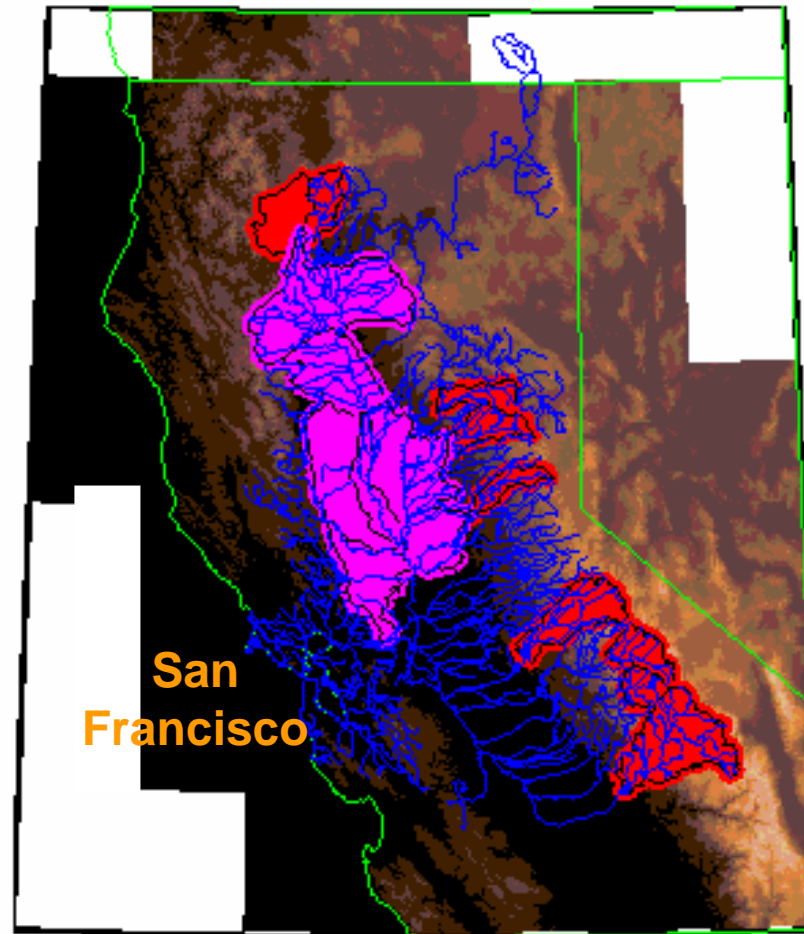


...followed by Upscaling:

-- “Headwater Basin” Climate

-- “Demand Area” Climate

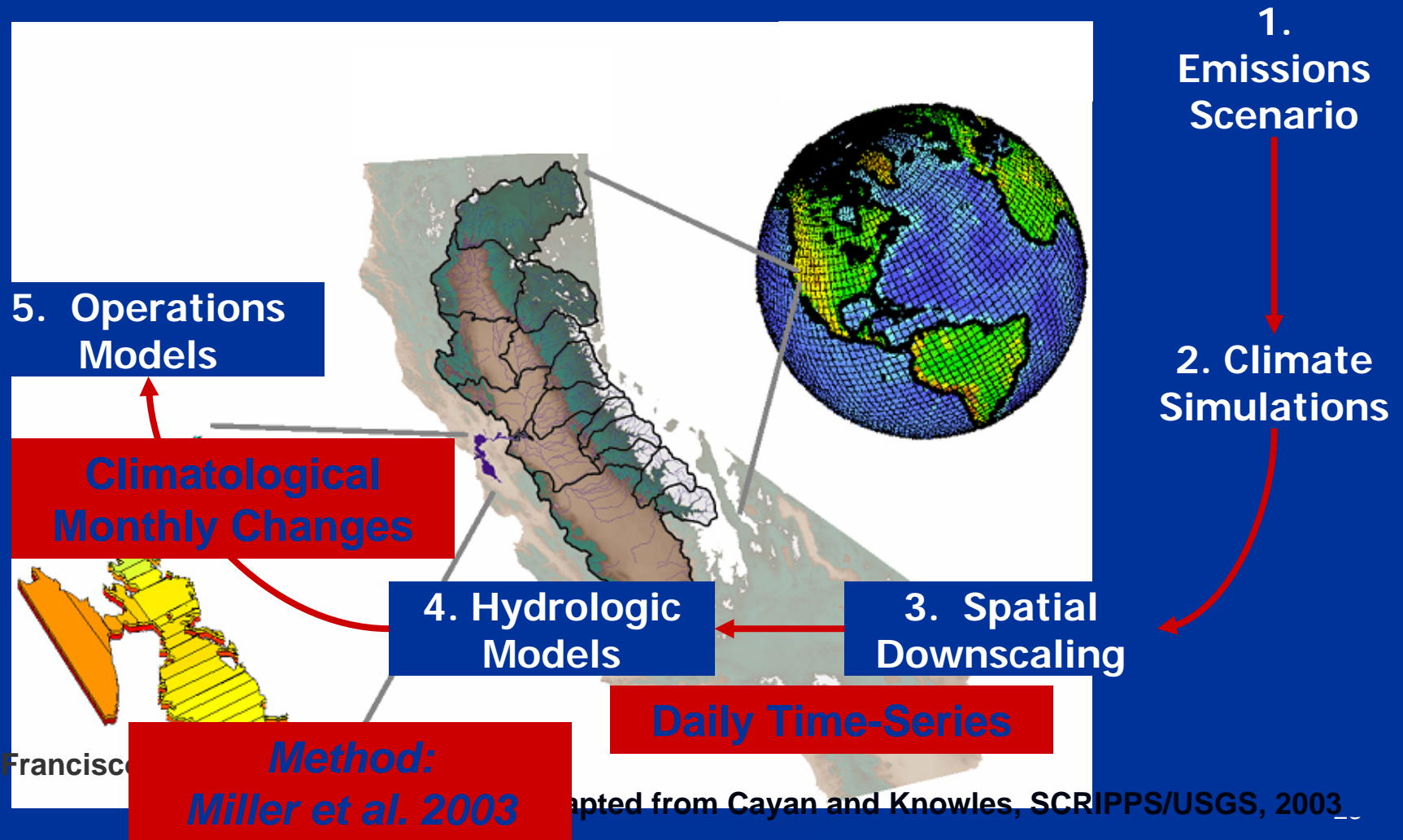
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Land
Surface
Elevation
(m)

Temporal Information

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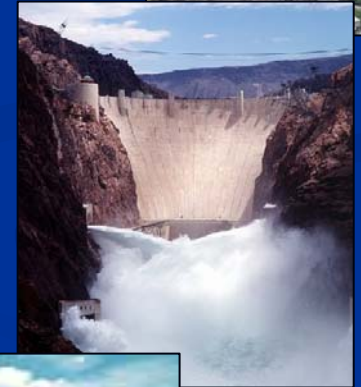
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USACE Climate Variability PDT Efforts

USACE is taking a Multi-Phase Approach

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- Phase I – Establish a Foundation Document
 - Explicitly identify how the Corps will be vulnerable to Climate Variability
 - Draw from on the ground knowledge and experience of water managers in Western USACE Districts
 - Assimilate information from surveys into the Foundation Document



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■ Phase II – Pilot Projects

- Identify Pilot Projects that correlates to the vulnerable missions identified in Phase I
 - Hydropower, Flood Control, Agriculture, Water Supply, Environmental Restoration, Regulatory, Navigation, etc.
- Scope & Secure funding to execute the projects

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■ Phase III – Develop Tools & Guidance via Pilot Projects

- Develop tools that facilitates planning & water management activities
- Identify procedures to incorporate climate into planning & water management activities
- Develop guidelines for estimating climate related risks & uncertainties within the planning process

Results of Survey – Climate Drivers and Impact Pathways

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Drivers

- Regional temperature shifts
- Increased variability and uncertainty in forecasts
- Seasonal timing of large storm events
- Altered seasonality and volume of precipitation

Pathways

- Water temperature
- Streamflow timing shifts (shape of hydrograph)
- Annual runoff volume altered
- Pattern of snow accumulation and melt
 - Watersheds: snow-dominant → rain dominant
- Altered risks for streamflow extremes (high and low flow)

Results of Survey – USACE Missions

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■ Flood Damage Reduction Activities

- Flood Damage Reduction Projects
- Flood Insurance Studies
- Floodplain Management Services
- Flood Control Operations

■ Navigation

■ Hydropower

■ Recreation

■ Ecosystem Restoration

- ESA (Biological Opinions)
- Fish Passage
- Instream Flow Augmentation
 - Habitat (Rearing, Migration, Spawning)
 - Water Quality (Temperature, Salinity ...)

■ Water Supply

- Urbanization - Agricultural vs. M&I demand shifts
- Uncertainty in water supply forecasting

Results of Survey – Planning and Management

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- **Flexible Rule Curves & Storage Reservoir Diagrams (SRD)**
- **Changing Operations at Dams**
 - Reservoir evacuation & refill schedules
 - Elevation control of Lakes (i.e. Lake Washington)
 - New Water Control Plans
 - Changes to Reservoir/water allocations and/or prioritization
 - Changing storage needs
- **Structural design changes for construction projects**
 - Levees, flood risk reduction
- **Streamflow forecasts**
 - Higher resolution remote sensing
 - Reduced uncertainty required
 - Updated decision support tools
- **Biological Opinions (BiOp)**
 - RPA and RPM's
 - Restoration of normative annual hydrographs & thermographs

Ongoing Effort

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- We have just started this process
 - Developed a survey approach
 - Using a simple one-page template
 - Currently, conducting surveys of the USACE offices
 - Hope to have the surveys completed in the next couple months
- Goal is to have pilot projects identified after surveys are complete
- Execute projects over couple years